PROTECTA
Electronics Co. Ltd

EuroProt

complex protection

DRFP-EP

factory configuration

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1 Application

The members of the **EuroProt** complex protection series are basically modular devices. The modules are assembled and configured according to the required protection functions. This manual describes the specialities of one of the numerous applications: the **DRFP-EP** factory configuration. The general user's manual for the **EuroProt** devices is the document „EPCP-2004 EuroProt complex protection, hardware and software manual", (further „*EPCP-2004*"), which provides all common information to the members of the **EuroProt** complex protection series.

The **DRFP-EP** complex numerical device made by PROTECTA Co. Ltd. is pre-configured for **D**igital **R**ailway **F**eeder **P**rotection. This device can be applied for all protection and auxiliary functions for single phase AC traction supply systems.

1.1 Features

The main features of **DRFP-EP** complex protection are as follows:

- The complex device implements the following functions:
  - distance protection with 5 zones,
  - overcurrent time protection (I>>) IDMT,
  - thermal protection,
  - over/undervoltage protection,
  - automatic reclosing.
- Features of the protection functions:
  - all functions can be individually switched to be operative or inoperative;
  - the setting values and time delay of the functions can be set independently of each other.
- Additional features:
  - fault location,
  - PROTLOG equations,
  - event recorder,
  - disturbance recorder,
  - self monitoring,
  - circuit breaker trip and close coil supervision,
  - voltage transformer circuit supervision,
  - metering.
- An integrated real-time clock is implemented with battery supported RAM. The clock can be synchronised by external PC or by the supervisory and control system, and additionally a Word Time Synchroniser (GPS-OP) produced by PROTECTA Co. Ltd can be ordered optionally.

1.2 Main hardware features

The **DRFP-EP** complex digital protection is a full numerical system, based on powerful microcontrollers. Within the limits of the hardware the functions are determined by the software.

The design, and the man-machine interface of the device is described in „*EPCP-2004*" manual.

The man-machine interface of the device is the integrated 2x16 character LCD, the simple keyboard with 6 pushbuttons and the 7 LED-s on the front panel. The device can be supervised easier with a connected PC, which runs the windows-based operating program „Protect for Windows", developed by Protecta Co. Ltd. The user's manual for all these possibilities is the „*EPCP-2004"* documentation.

The medium for the external communication is the 2 kV isolated serial RS 232 interface located on the front panel of the device, or the two integrated fibre optic interfaces, connectors on the back panel. For the serial communication please find detailed information in the „*EPCP-2004*" documentation.

2 The protection functions

The DRFP-EP complex numerical protection implements the following protection functions for single phase AC traction supply systems:

- distance protection with 5 zones,
- overcurrent time protection (IDMT),
- thermal protection,
- over/undervoltage protection,
- automatic reclosing.

These functions are independent of each other, they can be set individually. The functions can be individually set to be operative or inoperative. The following chapters describe the protection functions.

2.1 Distance protection with 5 independent zones

One of the basic functions of the complex protection is the distance protection. For the first zone the operation is based on three sampled voltage and current values. This algorithm is very fast, and insensitive of CT saturation. The operation of the first zone protection is dependent on the starting of a dedicated undervoltage function as well.

For the other four zones the algorithm operates with Fourier filtering. Using this method the operation is optimised for distorted waveform. If the calculated impedance is within the polygon characteristics of the zone, the function starts the timer. When the pre-set time is over the function generates trip command.

2.1.1 Distance characteristics

- Zone 1 is directed forward, the operation depends on undervoltage function.
- Zone 2 is directed forward, and can operate with load impedance cut-off.
- Zone 3 and 4 can be directed forward or backward, and can operate with load impedance cut-off.
- Zone 5 has reverse direction.

Each of the zones has a quadrilateral characteristics. Parameters of the characteristics are as follows:

- Undervoltage control for zone 1,
- Resistive reach individually for each zones,
- Reactive reach individually for each zones,
- -R/X angular coefficient individually for each zones,
- -X/R angular coefficient individually for each zones,
- Direction (for zones 3 and 4) and load impedance cut-off (for zones 2, 3 and 4).

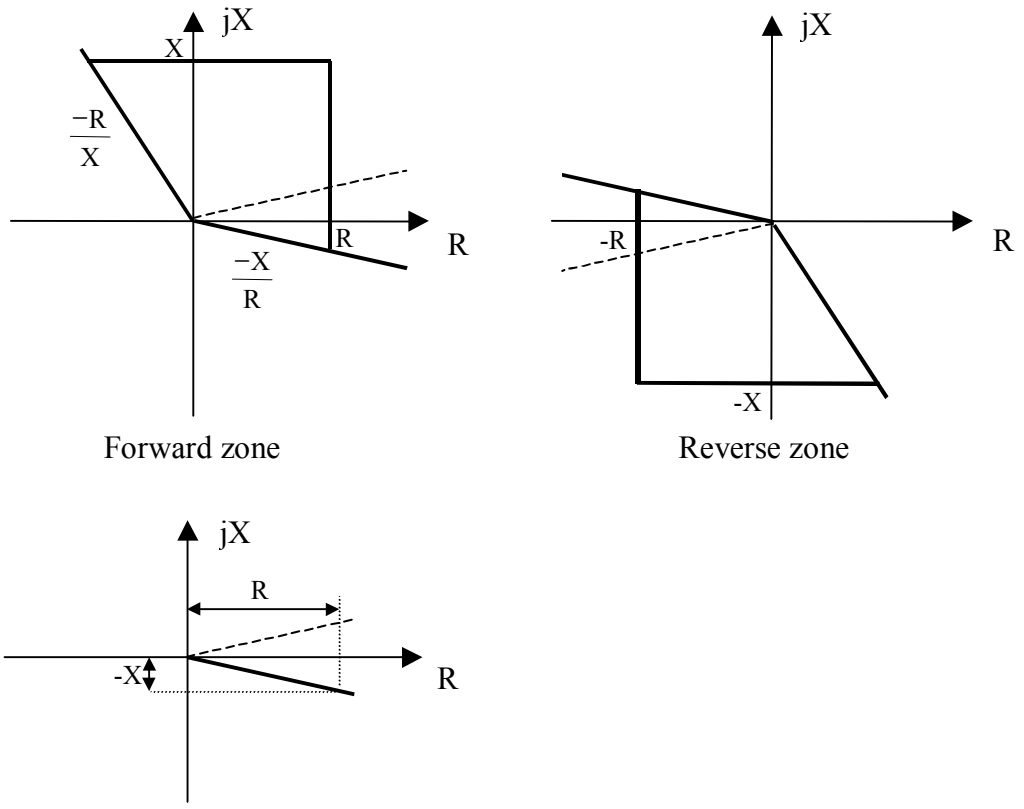


Fig. 1 Quadrilateral tripping characteristics.

Normal load impedance should not start the distance relay. Therefore the line of the characteristics determined by –X/ R can be mirrored to axis R in Zone 2,3,4. This can make the characteristics blind to the heavy load of the engine.
Parameter „Direction" can have the following values:

0: forward direction with no load impedance cut-off;
1: reverse direction with no load impedance cut-off;
2: forward direction with load impedance cut-off (-X/R is negated, so the line in the 4th quarter is turned into the 1st quarter;
3: reverse direction with load impedance cut-off (-X/R is negated, so the line in the 2nd quarter is turned into the 3rd quarter.

2.1.1.1 Polarising

The impedance measuring algorithms have to work correctly even if the voltage drops to nearly zero due to a close-up fault. A synchronous polarising system has been installed in order to decide the appropriate direction of the fault in such cases. The system is based on continuously storing the healthy voltage signal into a buffer until the voltage collapses. This healthy signal is available for about 80 ms after the drop of the voltage. If the current exceeds the minimal threshold (25-30% of In(CT)), the impedance measuring algorithm determines

the direction of the fault based on the stored voltage signal and will latch until either the voltage becomes healthy again or the current drops below the threshold.

Polarising initiates when voltage drops below 5V for the three point algorithm and latching ends when the voltage exceeds about 40 V. These values are 5V and 8V at Fourier filtering algorithm.

2.1.1.2 Energising of the line

If the line is energised while having a close-up fault, the voltage level can be under the polarising threshold making the relay unable to determine the direction of the fault. In such a case the relay assumes that the fault is in forward direction.

2.1.1.3 VT circuit supervision via MCB auxiliary contact

The impedance relay has to be blocked in case of a failure in VT circuit. This is achieved by monitoring the signal of *VT miniature (midget) CB* via an optically coupled isolator. This signal has to be active (VT circuit is healthy) for at least 200ms in order to enable impedance protection. Energising this optical isolator can mean either the healthy state of the VT circuit or it has a failure. The active level of the MCB indicating the healthy VT circuit can be selected by setting the related *VT miniature (midget) CB OK level on input* parameter. If this parameter is set to HIGH, the VT circuit is considered to be healthy if the input signal "*VT midget CB"* is energised. If the parameter is set to LOW, the VT circuit is considered to be healthy if the input signal "*VT midget CB"* is not energised.

2.1.1.4 Switch-on-to-fault logic

The relay has an input dedicated as "Manual close" to receive the close command from the auxiliary contact of the CB control switch. When this input goes high it is assumed that the line has been energised and the reclaim timer is started. If a fault occurs while this timer is running after receipt of manual close command, the relay will trip instantaneously in any zone.

2.1.1.5 Available communication schemes

Zone extension and permissive underreach schemes with programmable logical input levels can be achieved using PROTLOG equations.

2.1.1.6 Fault locator

DRFP-EP has an integrated fault locator. Based on setting the parameter *Xn* (total reactance of the line), the fault locator calculates the fault location in percent of the full length of the line. Fault locator is activated in Zone 2 therefore it only works if the fault occurs in the area of this zone. The result is also stored in the event recorder. For the last fault the LCD on the front panel of the device displays this distance as well.

2.1.1.7 Inactivating the zones

Each zone can be set to be inoperative using PROTLOG system. A user defined logic equation can be set to block the zone from tripping (*Z1 trip block, Z2 trip block, Z3 trip block, Z4 trip block, Z5 trip block*). The measuring, starting and timing procedure remains active while the zone trip is blocked, this way the user has the opportunity to use a zone element for signalling or other purposes. Blocking the trip of the zone forces the protection starting and tripping logic to ignore the start and trip signals of the appropriate zone.

2.1.2 Realisation of distance protection function

2.1.2.1 Analogue inputs

This function measures the current and the voltage of the line:

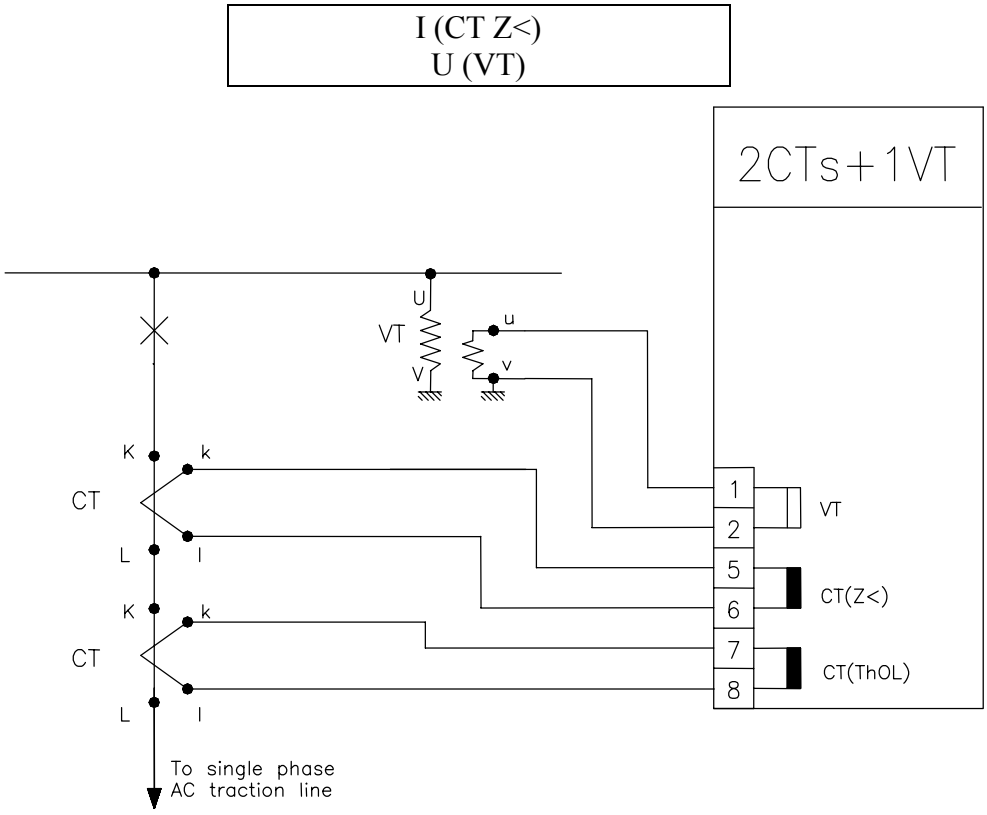


Figure 2 Correctly directed external connections

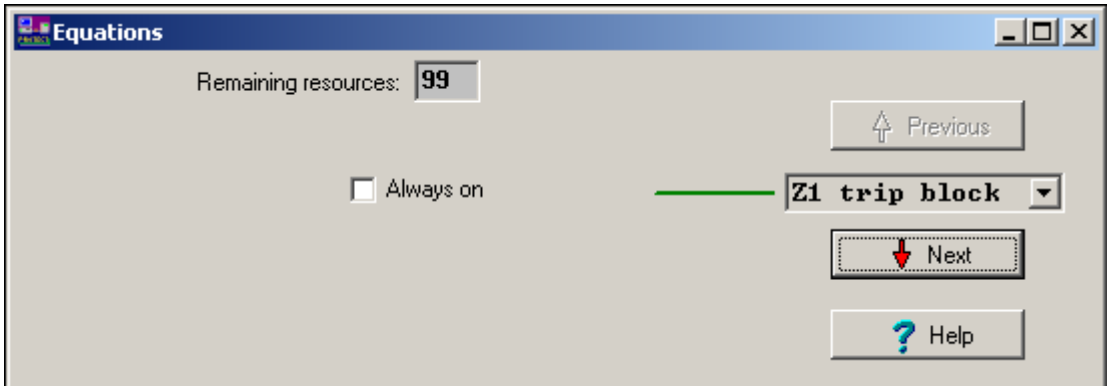
2.1.2.2 Parameter setting

The function needs setting of the following parameters:

LCD	Min	Max	Step	Explanation
U<Z1 (/Un[VT]) = %	5	120	1	Voltage setting of the first zone undervoltage function, below which the first zone is operable.
R1 (*10*Cu*Ci) = mOhm	10	10000	10	R setting of the polygon
X1 (*10*Cu*Ci) = mOhm	10	10000	10	X setting of the polygon
-R1/X1 = %	0	50	1	Angle setting of the polygon in negative R reach
-X1/R1 = %	0	50	1	Angle setting of the polygon in negative X reach
t (Z1<) = ms	0	60000	10	Time delay
R2 (*10*Cu*Ci) = mOhm	10	20000	10	R setting of the polygon
X2 (*10*Cu*Ci) = mOhm	10	20000	10	X setting of the polygon
-R2/X2 = %	0	50	1	Angle setting of the polygon in negative R reach
-X2/R2 = %	0	200	1	Angle setting of the polygon in negative X reach
Z2 direction /0, 2/	0	2	2	Load impedance cut-off
t (Z2<) = ms	0	60000	10	Time delay
R3 (*10*Cu*Ci) = mOhm	10	20000	10	R setting of the polygon
X3 (*10*Cu*Ci) = mOhm	10	20000	10	X setting of the polygon
-R3/X3 = %	0	50	1	Angle setting of the polygon in negative R reach
-X3/R3 = %	0	200	1	Angle setting of the polygon in negative X reach
Z3 direction /0..3/	0	3	1	Direction and load impedance cut-off
t (Z3<) = ms	0	60000	10	Time delay
R4 (*10*Cu*Ci) = mOhm	10	20000	10	R setting of the polygon
X4 (*10*Cu*Ci) = mOhm	10	20000	10	X setting of the polygon
-R4/X4 = %	0	50	1	Angle setting of the polygon in negative R reach
-X4/R4 = %	0	200	1	Angle setting of the polygon in negative X reach

Z4 direction /0..3/	0	3	1	Direction and load impedance cut-off
t (Z4<) = ms	0	60000	10	Time delay
R5 (*10*Cu*Ci) = mOhm	10	20000	10	R setting of the polygon
X5 (*10*Cu*Ci) = mOhm	10	20000	10	X setting of the polygon
-R5/X5 = %	0	50	1	Angle setting of the polygon in negative R reach
-X5/R5 = %	0	50	1	Angle setting of the polygon in negative X reach
t (Z5<) = ms	0	60000	10	Time delay
XnLine*10*Cu*Ci= mOhm	100	20000	10	Total reactance of the line
Line length [km]	0	1000	1	Total length of the line in km
CT primary nom= A	100	2500	1	CT primary rated current
VT primary nom/10= V	100	6000	1	VT primary rated voltage divided by 10 (e.g. for 120'000 V this value is 12'000)
VT MCB OK level /+=HIGH/	-	+		Voltage level indicating the healthy state of the VT circuit
2nd trip.coil? /+=yes/	-	+		Second trip coil is to be operated

The enabling of the functions is solved with „PROTLOG" logic equations. As an example the enabling of the first zone (The Fig. shows the default setting. If the check-box "Always on" is checked, then the first zone cannot generate a trip command.):



Enabling the first distance zone with „PROTLOG" logic equation (example)

2.1.2.3 Outputs of the function

The functions give trip command on the relay contacts "To I.Trip.Output" and "To II.Trip.Output" (if any), and deliver status signals indicating the operation.

2.1.2.4 Displayed information

Displayed information on the integrated LCD of the device, in the „*Test*" menu:

Measured analogous signals:

LCD information	Explanation
I (Z) = [A]	Measured current
U = [V]	Measured voltage
R sec. [Ohm]=	Calculated resistance value in secondary Ohms*Cu*Ci
X sec. [Ohm]=	Calculated reactance value in secondary Ohms*Cu*Ci
Fault loc. = [km]	Distance to fault for the last event, in km

Digital information:

LCD information	Explanation
1. status bits:	
Z1 pos.1	Distance protection start in zone 1
Z2 pos.2	Distance protection start in zone 2
Z3 pos.3	Distance protection start in zone 3
Z4 pos.4	Distance protection start in zone 4
Z5 pos.5	Distance protection start in zone 5
2. status bits:	
Start pos.2	General start signal
Trip pos.3	General trip command

2.1.2.5 Messages of the function:

The messages on the LCD of the device related to the function:

```
Z1< tripped!
Z2< tripped!
Z3< tripped!
Z4< tripped!
Z5< tripped!
Definite trip!
```

To disable these messages a binary parameter must be set:

LCD	Explanation
`Block oper.mess. /+= yes/`	When set to "+", the messages will not be displayed

2.1.2.6 Event recording

The event recorder function records the following events with time stamp. See details of event recording in the „*EPCP-2004* documentation. The integrated LCD of the device can display the following messages:

```
Z1< started!
Z2< started!
Z3< started!
Z4< started!
Z5< started!
Z1< tripped!
Z2< tripped!
Z3< tripped!
Z4< tripped!
Z5< tripped!
Definite trip!
```

The Protect for Windows software displays the digital events in a separate window. See details in chapter "Digital events".

2.1.2.7 Evaluated events

The Protect for Windows software displays the evaluated event in a separate window. See details in chapter "Evaluated events".

2.1.2.8 Event counters

The distance protection function involves the following counters (displayed on the integrated LCD of the device):

```
Z1< start cnt=
Z2< start cnt=
Z3< start cnt=
Z4< start cnt=
Z5< start cnt=
Z1< expired cnt=
Z2< expired cnt=
Z3< expired cnt=
Z4< expired cnt=
Z5< expired cnt=
Trip command cnt=
```

The counter values are displayed in the „On-line" PC screen as well.

2.1.2.9 PROTLOG equation input variables

The status signals of the distance protection function are input variables of the PROTLOG equations.

2.1.2.10 Signals recorded in the disturbance recorder

The integrated disturbance recorder records the following signals:

Analogue signals:

Signal	Explanation
I (Z) %	Measured current in the CT(Z<) input related to the In(CT)
U %	Measured voltage related to the Vn(VT)

Digital signals:

Signal	Explanation
Z1_started	Distance protection Zone 1 start
Z2_started	Distance protection Zone 2 start
Z3_started	Distance protection Zone 3 start
Z4_started	Distance protection Zone 4 start
Z5_started	Distance protection reverse zone start
Z1t_expired	Distance protection Zone 1 trip command
Z2t_expired	Distance protection Zone 2 trip command
Z3t_expired	Distance protection Zone 3 trip command
Z4t_expired	Distance protection Zone 4 trip command
Z5t_expired	Distance protection reverse zone trip command
Start	General start
Protection_trip	General trip command

2.2 Overcurrent time protection (IDMT)

This function is an overcurrent protection with current dependent characteristics.

2.2.1 The characteristics

The algorithm determines the base harmonic of the current using Fourier method then the current dependent characteristic is applied. The timing is limited by a minimum operating time. This protection function uses the standard current dependent characteristics:

Normal inverse (Type =0)

$$T = T_N \frac{0.14}{\left(\frac{I}{I_N}\right)^{0.02} - 1}$$

Very inverse (Type =1)

$$T = T_N \frac{13.5}{\left(\frac{I}{I_N}\right)^{1} - 1}$$

Extremely inverse (Type =2)

$$T = T_N \frac{80}{\left(\frac{I}{I_N}\right)^{2} - 1}$$

For all cases the rated current (I_N) and the time multiplier (T_N) must be set.

2.2.2 Realisation of the function

2.2.2.1 Analogue input of the function

The analogue input of the function is the current measured on dedicated current input:

Iv CT(Z<)

2.2.2.2 The parameters of the function

LCD text	Min	Max	Step	Explanation
IDMT type(0,1,2)	0	2	1	(0: inverse, 1: very inverse, 2: extremely inverse)
IDMT M const.	1	256	1	Time multiplier multiplied by 20 (M) $M=20*T_N$
Ibasic/Ctnom*100 %	20	150	1	Current setting, related to the rated current of the CT, multiplied by 100 (E.g. for setting of 0.5 the value to be set is 50)

The enabling of the functions is solved with „PROTLOG" logic equations. As an example the enabling of the first zone of the distance protection is shown in Chapter 2.1.2.2. (The Fig. shows the default setting. If the check-box "Always on" is checked, then the first zone cannot generate a trip command.) The logic variable to be handled is: "IDMT trip block"

2.2.2.3 Digital outputs of the function

The functions give trip command on the relay contacts "To I.Trip.Output" and "To II.Trip.Output" (if any), and deliver status signals indicating the operation.

2.2.2.4 Displayed information

Displayed information on the integrated LCD of the device, in the „*Test*" menu:

Measured analogous signals:

LCD information	Explanation
I (Z) = [A]	Measured current
IDMT =	Countdown starting at 1000 if the function operates

Digital information:

LCD information	Explanation
2. status bits:	
Start pos.2	General start signal
Trip pos.3	General trip command

2.2.2.5 Messages of the function:

The messages related to the function are:

```
IDMT tripped!
Definite trip!
```

To disable these messages a binary parameter must be set:

LCD	Explanation
`Block oper.mess. /+= yes/`	When set to "+", the messages will not be displayed

2.2.2.6 Event recording

The event recorder function records the following event with time stamp. See details of event recording in the „*EPCP-2004* documentation. The integrated LCD of the device can display the following message:

```
IDMT tripped!
```

2.2.2.7 Evaluated events

The Protect for Windows software displays the evaluated event in a separate window. See details in chapter "Evaluated events".

2.2.2.8 Event counters

The IDMT protection function involves the following counters (displayed on the integrated LCD of the device):

```
IDMT expired cnt
Trip command cnt
```

The counter values are displayed in the „On-line" PC screen as well.

2.2.2.9 PROTLOG equation input variables

The status signals of the IDMT protection function are input variables of the PROTLOG equations.

2.2.2.10 Signals recorded in the disturbance recorder

The integrated disturbance recorder records the following signals related directly to this function:

Analogue signal:

Signal	Explanation
`I (Z) %`	Measured current in the CT(Z<) input related to the In(CT)

Digital signal:

Signal	Explanation
IDMT_expired	Trip command of the IDMT function
Protection_trip	General trip command

2.3 Thermal protection

The electrical equipment (overhead lines, motors, transformers, cables, etc.) can withstand high overload current for a short time, but a relatively small overcurrent, which flows for a long time can lead to overheating and damages of the equipment. The current dependent inverse type characteristics disconnect the circuit breaker quicker if the current increases, but they cannot provide suitable protection against overheating. This is because a considerably longer time is needed to reach the critical temperature, if the heating starts in a cold state, then in case of starting in a warm operating state. This problem is solved by the thermal overload protection, which calculates the temperature based on the measured current. If the temperature approaches the critical temperature, the function generates a warning signal, and at the critical temperature trips the circuit breaker.

Calculation of temperature rise will be reset (the calculated over-temperature will be set to 0) after switching on the relay or downloading the parameter set.

2.3.1 Principle of measurement

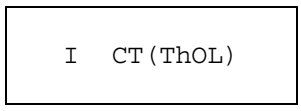
The temperature of equipment - relatively to the environment - is determined by the balance of the internal generated heat and the heat radiated into the environment. Based on this physical model a differential equation can be established, the step-by-step solution of which is the principle of the thermal overload protection. If the thermal parameters of the equipment are known, then based on the measured current the thermal state (temperature) of the equipment can be calculated continuously. The algorithm "remembers" the former load current, and takes the natural cooling into consideration as well.

If the temperature approaches the setting value of the warning temperature, the protection generates a warning signal, and at the critical temperature trips the circuit breaker.

2.3.2 Realisation of thermal protection function

2.3.2.1 Analogue inputs of the function

The function measures the current on a dedicated input CT(ThOL):



2.3.2.2 Parameters of the function

LCD text	Min	Max	Step	Explanation
Θt/Θn (trip) = %	80	250	1	Trip temperature as percent of the rated temperature
Θpre/Θn (alarm)= %	80	250	1	Alarm temperature as percent of the rated temperature
In(line)/In(CT)= %	10	500	1	Rated current of the line as percent of the rated CT current
Θn(nom.overheat) °C	0	200	1	Rated over-temperature at rated current
Time constant = s	0	2000	1	Thermal time constant

The enabling of the functions is solved with „PROTLOG" logic equations. As an example the enabling of the first zone of the distance protection is shown in Chapter 2.1.2.2. (The Fig. shows the default setting. If the check-box "Always on" is checked, then the first zone can not generate a trip command.) The logic variable to be handled is: "ThOL trip block"

2.3.2.3 Digital outputs of the function

The functions give trip command on the relay contacts "To I.Trip.Output" and "To II.Trip.Output" (if any), and deliver status signals indicating the operation.

2.3.2.4 Displayed information

Displayed information on the integrated LCD of the device, in the „*Test*" menu:
Measured analogous signals:

LCD information	Explanation
I (Th) = [%]	Measured current related to the In(CT)
Overtemp. [°C]	Calculated temperature above the ambient temperature

Digital information:

LCD information	Explanation
1. status bits:	
ThWarn pos.6	Signal of the thermal protection
2. status bits:	
ThTrip pos.1	Trip command of the thermal protection
Start pos.2	General start signal
Trip pos.3	General trip command

2.3.2.5 Messages of the function:

The messages related to the function:

```
Th. overload    tripped!
Definite trip!
```

To disable these messages a binary parameter must be set:

LCD	Explanation
`Block oper.mess. /+= yes/`	When set to "+", the messages will not be displayed

2.3.2.6 Event recording

The event recorder function records the following events with time stamp. See details of event recording in the „*EPCP-2004* documentation. The integrated LCD of the device can display the following messages:

```
Th. OL alarm!
Th. OL tripped!
Definite trip!
```

The Protect for Windows software displays the digital events in a separate window. See details in chapter "Digital events".

2.3.2.7 Evaluated events

The Protect for Windows software displays the evaluated event in a separate window. See details in chapter "Evaluated events".

2.3.2.8 Event counters

The thermal protection function involves the following counters (displayed on the integrated LCD of the device):

```
ThOL warning cnt =
ThOL expired cnt =
Trip command cnt =
```

The counter values are displayed in the „On-line" PC screen as well.

2.3.2.9 Signals recorded in the disturbance recorder

The integrated disturbance recorder records the following signals:

Analogue signals:

Signal	Explanation
IvTh %	Measured current in the CT(ThOL) input related to the In(CT)

Digital signals:

Signal	Explanation
Th.OL_prealarm	Warning signal of the thermal protection
Th.OL_expired	Trip command of the thermal protection
Protection_trip	General trip command

2.4 Over/undervoltage protection

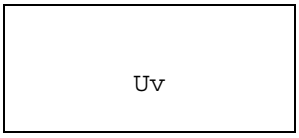
2.4.1 Principle of measurement

The algorithm measures the voltage, and for this voltage the base Fourier component is calculated. The function starts, if the voltage is above / below the setting value.

2.4.2 Realisation of over/undervoltage protection function

2.4.2.1 Analogue inputs of the function

The analogue input signal of the function is the voltage:



2.4.2.2 The parameters of the function

The function needs setting of the following parameters:

LCD text	Min	Max	Step	Explanation
U< (/Un[VT])= %	5	120	1	Voltage setting value for the undervoltage function related to the voltage transformer rated value
U> (/Un[VT])= %	70	130	1	Voltage setting value for the overvoltage function related to the voltage transformer rated value
VT primary nom./10= V	100	6000	1	Primary rated voltage of the voltage transformer divided by 10 calculated for the rated voltage of the voltage input (110 V)
t(U<) = ms	0	60000	1	Delay time of the undervoltage function
t(U>) = ms	0	60000	1	Delay time of the overvoltage function

The enabling of the functions is solved with „PROTLOG" logic equations. As an example the enabling of the first zone of the distance protection is shown in Chapter 2.1.2.2. (The Fig. shows the default setting. If the check-box "Always on" is checked, then the first zone can not generate a trip command.) The logic variables to be handled are: "U< trip block" and "U> trip block". The trip command of the over/undervoltage function is allways a definite trip command.

2.4.2.3 Digital outputs of the function

The functions give trip command on the relay contacts "To I.Trip.Output" and "To II.Trip.Output" (if any), and deliver status signals indicating the operation.

2.4.2.4 Displayed information

Displayed information on the integrated LCD of the device, in the „*Test*" menu:

Measured analogue signals:

LCD information	Explanation
U = [V]	Measured voltage

Digital information:

LCD information	Explanation
1. status bits:	
Uk pos.7	Signal of the undervoltage function
Un pos.8	Signal of the overvoltage function
2. status bits:	
Start pos.2	General start signal
Trip pos.3	General trip command

2.4.2.5 Messages of the function:

The messages related to the function are:

```
U< tripped!
U> tripped!
Definite trip!
```

To disable these messages a binary parameter must be set:

LCD	Explanation
Block oper.mess. /+= yes/	When set to "+", the messages will not be displayed

2.4.2.6 Event recording

The event recorder function records the following events with time stamp. See details of event recording in the „*EPCP-2004* documentation. The integrated LCD of the device can display the following messages:

```
U< started!
U> started!
U< tripped!
U> tripped!
Definite trip!
```

The Protect for Windows software displays the digital events in a separate window. See details in chapter "Digital events".

2.4.2.7 Evaluated events

The Protect for Windows software displays the evaluated event in a separate window. See details in chapter "Evaluated events".

2.4.2.8 Event counters

The counters related to the function are:

```
U< expired cnt
U> expired cnt
```

2.4.2.9 Signals recorded in the disturbance recorder

The integrated disturbance recorder records the following signals:

Analogue signals:

Signal	Explanation
U [%]	Measured voltage related to the Vn(VT)

Digital signals:

Signal	Explanation
U>_started	Start of the overvoltage function
U<_started	Start of the undervoltage function
U>_expired	Trip command of the overvoltage function
U<_expired	Trip command of the undervoltage function
Start	General start signal
Protection_trip	General trip command

2.5 Automatic reclosing

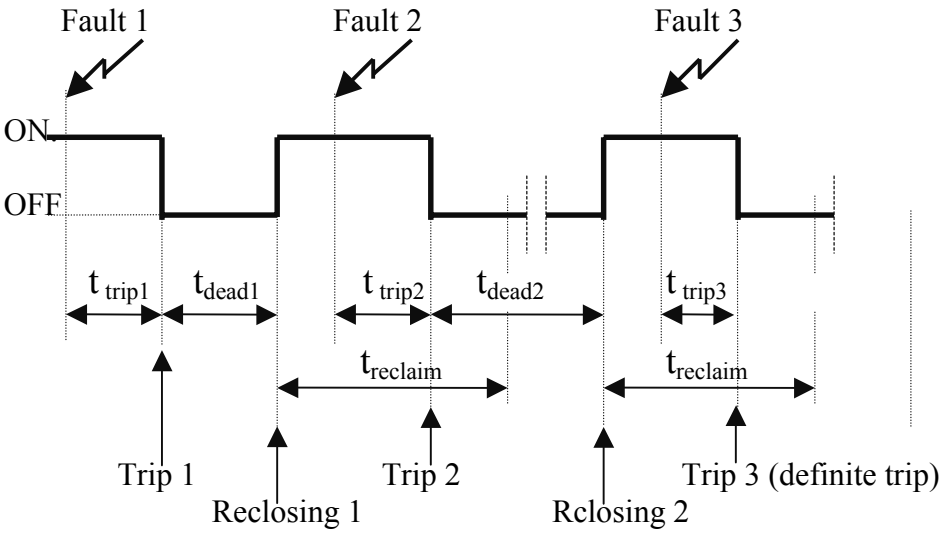
2.5.1 Main characteristics of the function

The automatic reclosing function performs two stage reclosing cycles.

Main characteristics of the automatic reclosing function:
- reclosing stage 1
- reclosing stage 2

Both reclosing stages can be enabled or disabled, independently of each other.

A possible full two stage reclosing sequence is shown on the following Figure.



Legend:

ON : CB ON
OFF : CB OFF

A full reclosing sequence

The diagram above shows a full reclosing sequence, if all cycles are enabled, and the fault returns after each reclosing within the "$t_{reclaim}$" time. The protection function (e.g. distance protection) trips, and starts the subsequent reclosing cycle. If any of the cycles is disabled, or the fault does not return, then the part of the diagram or the subsequent cycles will be missing.

The dead times can be set independently of each other. The "$t_{reclaim}$" time is the same duration for both stages.

Automatic reclosing is generally started by the falling edge of the tripping signal (if starting is not disabled by PROTLOG equations) and the external input AR START. The internal logic decides then whether to start a timer for dead time interval or to issue a definite trip signal, by taking the AR enable and blocking conditions into consideration. Reclose command will start the reclaim timer. If a consecutive fault occurs after the reclose command within the reclaim time, the procedure results in a definite trip blocking any further close command for a period of reclaim time.

Automatic reclosing function has several possibilities of enabling and blocking.

- *„AR disable"* parameter. If this binary parameter is set, every trip and external *AR start* signal will cause a definite trip signal and no reclose command will be issued. Resetting this parameter will not automatically enable automatic reclosing function. All other blocking conditions listed below have to be inactive in order to enable automatic reclosing.
- External *AR DISABLE* and *AR ENABLE* signals. These signals operate an internal SET/RESET flip-flop. An impulse on *AR DISABLE* will set the blocking condition. An impulse on *AR ENABLE* will reset this blocking condition if *AR DISABLE input* is not active at the same time. If this blocking condition is set, every trip and external *AR START* signal will cause a definite trip signal and no reclose command will be issued.
- *AR step1 inhibit, AR step2 inhibit* PROTLOG equation outputs. While these signals are active, every trip and external *AR START* signal will cause a definite trip signal and no reclose command will be issued.
- *LOW GAS* external input. As long as this signal is active, no close (and trip) command is issued and every internal trip condition and external *AR START* signal will cause a definite trip signal. The "low gas" information is latched until acknowledgement.
- Impulse on *MANUAL CLOSE* input, automatic reclosing command and definite trip start the reclaim timer. While this timer is running, the automatic reclosing is blocked and every trip and external *AR START* signal will cause a definite trip signal and no reclose command will be issued.
- SW2 pushbutton pressing (rising edge) is a toggle switch for disabled/enabled state of the automatic reclosing.

In some application *MANUAL CLOSE* input is used to force the relay to issue a close command. This application can be enabled by the „*Close if MC inp"* binary parameter.

Control commands on serial communication can force the relay to issue a trip or a close command. A remote trip command in this case will always act like a definite trip and a remote close command will act as if it were a manual close.

The duration of the close command issued by the relay can be determined by the „*t (Close)"* parameter.

2.5.2 Realisation of the function

2.5.2.1 Analogue inputs of the function

The function does not need independent analogue input values, the triggering is performed by other protection functions (distance protection, overcurrent protection, etc.) or an external command received on a digital input can initiate reclosing as well.

2.5.2.2 The parameters of the function

The function needs setting of the following parameters:

LCD text	Min	Max	Step	Explanation
t1 (Dead time)= s	0	600	1	Dead time for the first reclosing
t2 (Dead time)= s	0	600	1	Dead time for the second reclosing
t (Close) = ms	0	60000	10	Impulse time of the close command
t (Trip min.)= ms	0	60000	10	Minimal impulse time of the trip command
t (Reclaim) = ms	0	60000	10	Reclaim time
Z1< start AR ? /+=yes/				Distance protection Zone 1 starts automatic reclosing
Z2< start AR ? /+=yes/				Distance protection Zone 2 starts automatic reclosing
Z3< start AR ? /+=yes/				Distance protection Zone 3 starts automatic reclosing
Z4< start AR ? /+=yes/				Distance protection Zone 4 starts automatic reclosing
IDMT start AR ? /+=yes/				IDMT overcurrent function starts automatic reclosing
AR disable /+=yes/				Automatic reclosing disabled, no other means for enabling is possible

2.5.2.3 Digital outputs of the function

The function gives trip command on the relay contacts "To I.Trip.Output" and "To II.Trip.Output" (if any), delivers status signals indicating the operation. The close command is generated to output "To Close Output".

2.5.2.4 Displayed information

Digital information:

LCD information	Explanation
2. status bits:	
Trip pos.3	General trip command
AR disabled pos.4	Automatic reclosing function is disabled

2.5.2.5 Messages of the function:

The messages related to the function:

```
Definite trip!
1.auto reclose!
2.auto reclose!
```

To disable these messages a binary parameter must be set:

LCD	Explanation
Block oper.mess. /+= yes/	When set to "+", the messages will not be displayed

2.5.2.6 Event recording

On the LCD of the device the displayed events related to the function are as follows:

```
AR was blocked!
Aut. reclose!
Definite trip!
```

The Protect for Windows software displays the digital events in a separate window. See details in chapter "Digital events".

2.5.2.7 Evaluated events

The Protect for Windows software displays the evaluated event in a separate window. See details in chapter "Evaluated events".

2.5.2.8 Event counters

The counter related to this function counts the close commands:

Close command cnt

2.5.2.9 Signals recorded in the disturbance recorder

The integrated disturbance recorder records the following signals:

Digital signals:

Signal	Explanation
AR_disable_input	Status of the input AR DISABLE
AR_enable_input	Status of the input AR ENABLE
AR_start_input	Status of the input AR START
SW2_AR_dis/en.	Status of the input SW2 pushbutton
AR_blocked	Blocked state of the automatic reclosing
Man._close_inp.	Status of the input MANUAL CLOSE
Trip command	Trip command
Protection_trip	General trip command
Close command	Close command
Definitive trip	Definitive trip command

2.6 Breaker failure protection

If any of the protection functions generates a trip command and the CB is closed then the timer of the CB failure protection starts. (The CB status is indicated by the two dedicated digital inputs CB CLOSED and CB OPEN. In case of contradiction a timer is started the expiry of which indicates "CB discrepancy".)

The timer of the CB failure protection can be stopped by the open state of the CB.

If the delay time expires, the following status variables are set to logic "1" state: "CB failure", "Definitive trip" and "AR disabled".

The function needs setting of the following parameters:

LCD text	Min	Max	Step	Explanation
t(CB failure)= ms	0	60000	10	Delay time for the CB failure protection function
t(CB discrep)=	0	60000	10	Delay time for the CB discrepancy state

The messages of the function are:

```
CB status discrepancy
CB failure
```

2.7 Additional implemented functions

2.7.1 PROTLOG equations

The available digital status signals are the input variables of the PROTLOG equation system, which can be „freely" programmed to set output variables of the equation system.

2.7.1.1 Inputs of the logic equations

The available inputs for the logic equations are listed in the following table:

Input	Explanation
Low gas inp.	Status of the LOW GAS digital input
VT midget CB OK	Status of the VT midget CB input
CB closed inp.	Status of the CB CLOSED input
CB open inp.	Status of the CB OPEN input
Man. close inp.	Status of the MANUAL CLOSE input
AR disable inp.	Status of the AR DISABLE input
AR enable inp.	Status of the AR ENABLE input
AR start inp.	Status of the AR START input
Remote reset in	Status of the REMOTE RESET input
Input 10	Status of free input 10
Input 11	Status of free input 11
Input 12	Status of free input 12
Input 13	Status of free input 13
Input 14	Status of free input 14
Input 15	Status of free input 15
Input 16	Status of free input 16
Z1 started	Distance protection zone 1 started
Z2 started	Distance protection zone 2 started
Z3 started	Distance protection zone 3 started
Z4 started	Distance protection zone 4 started
Z5 started	Distance protection zone 5 started
Th.OL prealarm	Thermal overload function alarm signal
U< started	Undervoltage function started
U> started	Overvoltage function started
t(Z1) expired	Distance protection zone 1 time over
t(Z2) expired	Distance protection zone 2 time over

t(Z3) expired	Distance protection zone 3 time over
t(Z4) expired	Distance protection zone 4 time over
t(Z5) expired	Distance protection zone 5 time over
IDMT expired	Overcurrent function time over
Th.OL.expired	Thermal overload function time over
U< expired	Undervoltage function time over
U> expired	Overvoltage function time over
Z1 tripped	Distance protection zone 1 trip command
Z2 tripped	Distance protection zone 2 trip command
Z3 tripped	Distance protection zone 3 trip command
Z4 tripped	Distance protection zone 4 trip command
Z5 tripped	Distance protection zone 5 trip command
IDMT tripped	IDMT function trip command
Th.OL tripped	Thermal overload function trip command
U< tripped	Undervoltage function trip command
U> tripped	Overvoltage function trip command
Prot. started	General start
Prot. tripped	General trip command
Z1 trip blocked	Distance protection zone 1 trip command disabled
Z2 trip blocked	Distance protection zone 2 trip command disabled
Z3 trip blocked	Distance protection zone 3 trip command disabled
Z4 trip blocked	Distance protection zone 4 trip command disabled
Z5 trip blocked	Distance protection zone 5 trip command disabled
IDMT trip block	IDMT function trip command disabled
Th.OL tr.blocked	Thermal overload protection trip command disabled
U< trip blocked	Undervoltage protection trip command disabled
U> trip blocked	Overvoltage protection trip command disabled
AR blocked	Automatic reclosing disabled
CB failure	Circuit breaker failure
Definite trip	Definite trip command
Self test error	Self test function detected error
CB status error	Circuit breaker status signal error
1.timer running	Free programmable timer1 is running
1.timer expired	Free programmable timer1 time over
2.timer running	Free programmable timer2 is running
2.timer expired	Free programmable timer2 time over
3.timer running	Free programmable timer3 is running
3.timer expired	Free programmable timer3 time over

The inputs on the PC screen, marked with „*" character are latched status signals.

2.7.1.2 Outputs of the logic equations

The possible outputs of the logic equations are listed in the following table:

Input	Explanation
Z1 trip block	Trip command for distance zone 1 disabled
Z2 trip block	Trip command for distance zone 2 disabled
Z3 trip block	Trip command for distance zone 3 disabled
Z4 trip block	Trip command for distance zone 4 disabled
Z5 trip block	Trip command for distance zone 5 disabled
IDMT trip block	Trip command for overcurrent function disabled
ThOL trip block	Trip command for thermal overload function disabled
U< trip block	Trip command for undervoltage function disabled
U> trip block	Trip command for overvoltage function disabled
AR step1 inhibit	Automatic reclosing first shot disabled
AR step2 inhibit	Automatic reclosing second shot disabled
Self test warning	Additional condition to operate the self-test contact output
K1 output contact	Contact 1
K2 output contact	Contact 2
K3 output contact	Contact 3
K8 output contact	Contact 8
LED1	LED 1
LED2	LED 2
LED3	LED 3
LED4	LED 4
LED5	LED 5
LED6	LED 6
1.ParSet active	The parameter set No. 1 is active
2.ParSet active	The parameter set No. 2 is active
3.ParSet active	The parameter set No. 3 is active
4.ParSet active	The parameter set No. 4 is active
Start 1.timer	Free programmable timer1 start
Stop 1.timer	Free programmable timer1 stop
Start 2.timer	Free programmable timer2 start
Stop 2.timer	Free programmable timer2 stop
Start 3.timer	Free programmable timer3 start
Stop 3.timer	Free programmable timer3 stop

2.7.1.3 Programming the PROTLOG equations

The PROTLOG equations can be programmed with the connected PC only, using Protect for Windows software. The method of programming is a graphical method, described in „*EPCU-2004*" documentation. (The man-machine interface of the device does not support PROTLOG programming).

2.7.2 Application of signals from the digital inputs

There are dedicated and free digital inputs.

Input	Name	Explanation
G/1	LOW GAS	CB drive low gas pressure
G/2	VT midget CB	Voltage transformer miniature circuit breaker status signal
G/3	CB CLOSED	CB closed
G/4	CB OPEN	CB open
G/5	MANUAL CLOSE	Manual close command
G/6	AR DISABLE	Automatic reclosing disable impulse
G/7	AR ENABLE	Automatic reclosing enable impulse
G/8	AR START	External start of automatic reclosing

F/1	REMOTE RESET	Remote reset command for latched signals
F/2	INP.10	Free for PROTLOG programming
F/3	INP.11	Free for PROTLOG programming
F/4	INP.12	Free for PROTLOG programming
F/5	INP.13	Free for PROTLOG programming
F/6	INP.14	Free for PROTLOG programming
F/7	INP.15	Free for PROTLOG programming
F/8	INP.16	Free for PROTLOG programming

2.7.3 Application of output relays

There are dedicated and free output relays.

The output relays with fix assignment issue the trip and close commands, the free relays can be programmed using the PROTLOG equations.

2.7.4 Application of the analogue outputs

The ***DRFP-EP*** factory configuration of the ***EuroProt*** devices is extended with an analogue output module containing two 4-20 mA output channels. Both outputs can be loaded up to 350 Ohm.

The signal of the output channel No.1 is proportional to the distance to fault:

Signal	4 mA	20 mA
Distance to fault	0 km	2*Length parameter setting

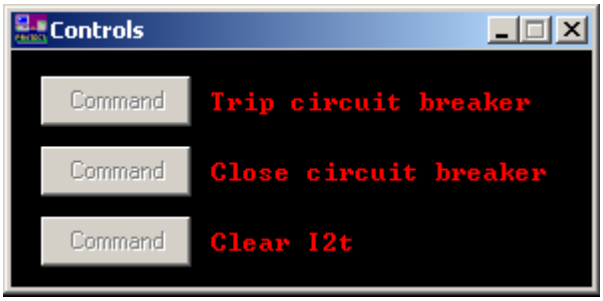
The signal of the output channel No.2 can be assigned with parameter setting (*2nd analogue output*):

Par.	Signal	4 mA	20 mA
1	I	≤0	CT primary rated value
2	U	≤0	1.2*VT primary rated value
3	S	≤0	60000 kVA
4	Q	≤0	40000 kvar
5	P	≤0	40000 kW
6	I2t	≤0	5000 kA^2s
7	cos fi	≤0	1

2.7.5 Circuit breaker control function

A dedicated window of „Protect for Windows" software is prepared to initiate switching commands to the circuit breaker. This window is displayed on the PC screen according to the figure below.

Both switching commands start a 300 ms timer. During runtime of these timers the output relay contacts "To I.Trip.Output" and "To II.Trip.Output" (if any), or the output "To Close Output" are closed.



Window for CB control

2.7.6 The disturbance recorder function

The CPU module includes a simplified disturbance recorder function. In the ***DRFP-EP*** device the disturbance recorder handles the sampled analogue data and the status signals. This function has not a man-machine interface; it can communicate only with a PC via fibre optic connection. The records can be analysed on the PC screen, can be sent to a central engineering workstation or can be printed as well.

The summary of the analogue signals sent to the disturbance recorder function:

Signal		Explanation
IvTh	%	Current of the CT (ThOL) input related to the In(CT)
Iv	%	Current of the CT (Z<) input related to the In(CT)
Uv	%	Voltage of the VT input related to the Vn(VT)

Summary of the status signals sent to the disturbance recorder function:

Signal	Explanation
Low_gas_inp	State of LOW GAS input
VT_MCB_inp	Signal of the miniature circuit breaker in the voltage transformer circuit
CB_closed_inp	Closed state of the circuit breaker
CB_open_inp	Open state of the circuit breaker
Man._close_inp	Manual circuit breaker close command
AR_disable_inp	Automatic reclosing disabled
AR_enable_inp1	Automatic reclosing enabled
AR_start_inp	Automatic reclosing external start
Rem._reset_inp	External acknowledgement
Inp. 10	Status of Input 10
Inp. 11	Status of Input 11
Inp. 12	Status of Input 12
Inp. 13	Status of Input 13
Inp. 14	Status of Input 14
Inp. 15	Status of Input 15
Inp. 16	Status of Input 16
SW1_reset	Status of switch 1 on the front panel of the device (Reset)
SW2_AR_dis/en.	Status of switch 2 on the front panel of the device (Automatic reclosing disable/enable)
Low_gas	Latched state of the LOW GAS input
VT_MCB_OK	Status of the miniature circuit breaker in the voltage transformer circuit
AR_blocked	Automatic reclosing disabled state
Self_test_error	General error signal of the device
Z1_started	Distance protection zone 1 started
Z2_started	Distance protection zone 2 started
Z3_started	Distance protection zone 3 started
Z4_started	Distance protection zone 4 started
Z5_started	Distance protection reverse zone started
Th._OL_prealarm	Thermal protection warning signal
U<_started	Undervolatage function started
U>_started	Overvolatage function started
Z1t_expired	Distance protection zone 1 trip command
Z2t_expired	Distance protection zone 2 trip command
Z3t_expired	Distance protection zone 3 trip command
Z4t_expired	Distance protection zone 4 trip command
Z5t_expired	Distance protection reverse zone trip command
IDMT_expired	IDMT function trip command
Th_OL_expired	Thermal protection trip command
U<_expired	Undervolatage function trip command
U>_expired	Overvolatage function trip command

Start	General start of protection functions
Protection_trip	General trip command of protection functions
Trip_command	General trip command
Close_command	General close command
Definitive_trip	Definitive trip command

The disturbance recorder function operates with factory settings. For the user the only possibility for interaction is to write logic equation for the triggering with the Protect for Windows program (see „*EPCP-2004*").

2.7.7 The free programmable timers

The program of the device provides three free programmable timers. The time delay of these timers can be set with parameters, the starting condition can be programmed with PROTLOG equations. With parameter setting the timers can operate as "operating" timer or as "resetting" timer. The timers send signals to the dedicated inputs of PROTLOG equations.

The function needs setting of the following parameters:

LCD	Min	Max	Step	Explanation
t(1.user timer)= ms	20	60000	10	Timer with 10 ms accuracy
t(2.user timer)= ms	20	60000	10	Timer with 10 ms accuracy
t(3.user timer)= s	1	600	1	Timer with 1 s accuracy
1.user timer mode /+=oper/	-	+		Timer operating mode: "-" Resetting timer "+" Operating timer
2.user timer mode /+=oper/	-	+		Timer operating mode: "-" Resetting timer "+" Operating timer
3.user timer mode /+=oper/	-	+		Timer operating mode: "-" Resetting timer "+" Operating timer

2.7.8 The LED signals

If any of the protective functions operate, the integrated LED-s on the front panel give quick information about the event. The LED assignment is based on PROTLOG equations. The LED signals can be latched by parameter setting.

The function needs setting of the following parameters:

LCD text	Min	Max	Step	Explanation
1.LED latched ?	-	+		Laching of LED 1
2.LED latched ?	-	+		Laching of LED 2
3.LED latched ?	-	+		Laching of LED 3
4.LED latched ?	-	+		Laching of LED 4
5.LED latched ?	-	+		Laching of LED 5
6.LED latched ?	-	+		Laching of LED 6

2.7.9 Displayed system messages

If any of the protection functions operates, or the self check system detects an error, then a message is displayed on the Front panel LCD. The following table lists the possible system message text elements.

```
EEPROM  error!
Memory battery error!
Self test: A/D & ADI error!
CB coil error!
+-15V DC failure!
No events since last deletion!
DRFP PROTECTA   26.08.2004.
```

The message must be acknowledged by pressing the ENT (ENTER) pushbutton. The effect is that the message disappears. When more than one messages are active; the first acknowledgement displays the next message. After the last active message the normal display function will be active again, and the red LED announcing the active messages disappears.

The active messages are not displayed in the correct event sequence but according to the list above.

The messages of the protection functions and the self-check error messages are logged in the event recorder with time stamp. The log can store up to 50 events with scanned analogue values. The time resolution is 1 ms. In the digital event sequence recorder up to 300 digital events can be recorded. These recorded events are stored after acknowledgement as well. The event log can be displayed on the man-machine interface of the device, on the PC screen via serial line using the Protect for Windows software, and the events are sent to the supervisory and control system too.

2.7.10 I^2t measurement

This function integrates the current square during trip command:

$$\int I^2 dt$$

where: I2 the square of the fault current in kA
t the time span starting with the trip impulse and ending with the interruption of the fault current.
The accumulated value can be reset to zero in the "Controls" window of the "Protect for Window" operating program.

2.7.11 Frequency measurement

This function performs Fourier filtering and measures the frequency of the voltage input.

2.7.12 Displayed values (Summary)

The algorithms as applied in the protection functions – as by-products – measure and calculate several quantities. These values can be displayed on the LCD of the device, they are listed on the PC screen when using the „Protect for Windows" software, they are sent to the supervisory and control system, and as an option, if the device contains a graphic display, they are shown here as well.

The measured values as default:

Value	Explanation
I(Th) [A] =	Base Fourier harmonic of current input CT (ThOL)
I(Z) [A] =	Base Fourier harmonic of current input CT (Z<)
U [V] =	Base Fourier harmonic of voltage
Fault loc.[%] =	Distance to fault as percent of the line length
R sec. [Ohm] =	Calculated resistance value in secondary Ohms * Cu*Ci
X sec. [Ohm] =	Calculated reactance value in secondary Ohms * Cu*Ci
P [kW] =	Active power with current input CT (Z<)
Q [kVar] =	Reactive power with current input CT (Z<)
S [kVA] =	Seeming power with current input CT (Z<)
F [mHz] =	Frequency measured on voltage input
IDMT =	Countdown to trip of the IDMT function
I2t [kA2s] =	(I^2t[kA^2s]) integrated current square during trip command where: I^2 the square of the fault current in kA, t the time span starting with the trip impulse and ending with the interruption of the fault current The accumulated value can be reset to zero in the „Control" window of the "Protect for Window" operating program.

2.7.13 Self check function

The correct operation of the program system is supervised by a „Watch-dog" circuit. Additionally the program includes cyclic test routines as well. This self-check system supervises:

- All internal errors of the device,
- The CB circuits,
- Additional error signalling can be configured using PROTLOG equations as well.

2.7.13.1 Internal error check

The internal error check supervises:

- the healthy state of the parameter memory,
- the power supply of the event memory (battery supported RAM),
- correct operation of the A/D converter,
- the correct ranges of the internal power supply voltage levels.

The messages in case of detected errors can be:

```
EEPROM error !
Memory battery error!
Self test : A/D & ADI error!
+- 15V DC       failure!
```

2.7.13.2 CB circuit check

If the check of the CB circuits is enabled then the continuous CB circuit test is carried out. The principle and the operation of this test are described in „*EPCP-2004*" documentation.

The specialities in this device are as follows:

- The device can check two CB circuits, if the second circuit is enabled by parameter setting.
- The function can be disabled by parameter setting.

The function needs setting of the following parameters:

LCD text	Min	Max	Step	Explanation
t(coil superv.)= s	0	600	1	Time delay for signalling detected error in CB circuit supervision
t(CB discrp.) = s	0	600	1	Time delay for signalling CB status discrepancy (One input should signal open state, the other not closed state or one input should signal closed state the other not open

				state. All other combinations cause error signal after this time delay.)
Coil test block?	-	+		Enabling the CB circuit check
2nd trip coil /+=Yes/	-	+		Enabling the second trip coil

The messages in case of detected errors can be:

CB status discrepancy! CB coil error! Trip or close coil error!

2.7.13.3 Operation of the self test output

The self test output contact of the device operates if:

- the check function of the device detects internal error (See 2.6.10.1) or
- the CB circuit check detects error (See 2.6.10.2) or
- the result „Self test warning" of the PROTLOG equation gets "logic 1".

2.8 Parameter packages

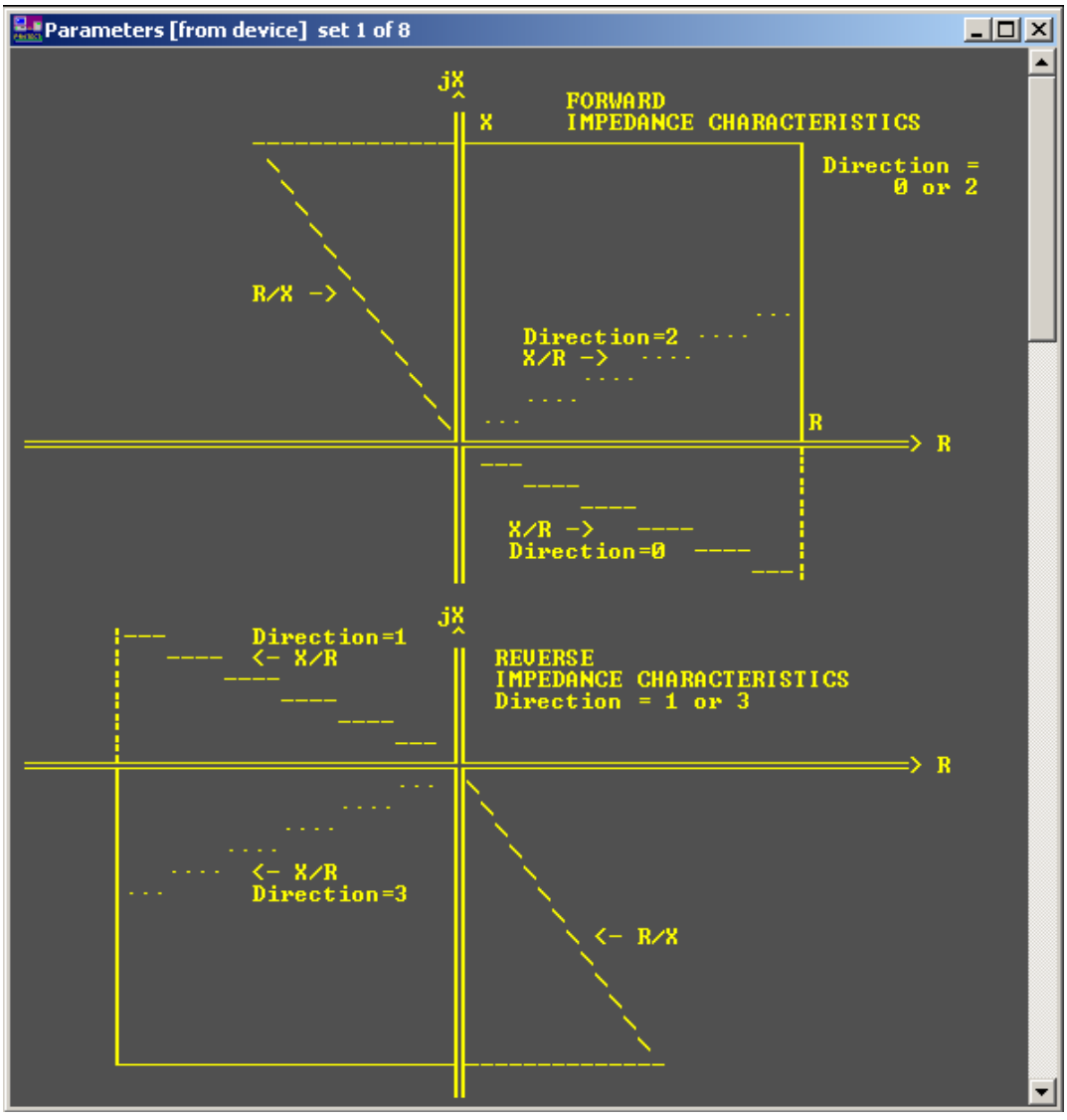
The device can be pre-programmed with up to 8 parameter packages. The selection between the packages can be performed either in "Protect for Window" operating program in the menu "Functions / Parameter set", or the first four parameter sets can be selected with PROTLOG equations as well. This second selection mode has priority, but it is possible only if the LCD menu item "Parameter/Comm/Pset Enable" enables (the setting is "+") this mode of operation. In this case PROTLOG equations must be edited for the output variables: "*1. ParSet active*", … "*4.ParSet active*" e.g. using the digital inputs as input variables of these PROTLOG equations. If more than one output is active then the first one in the numerical sequence decides the active parameter set. Be careful, all 8 parameter packages should contain the same equations concerning the four parameter packages!

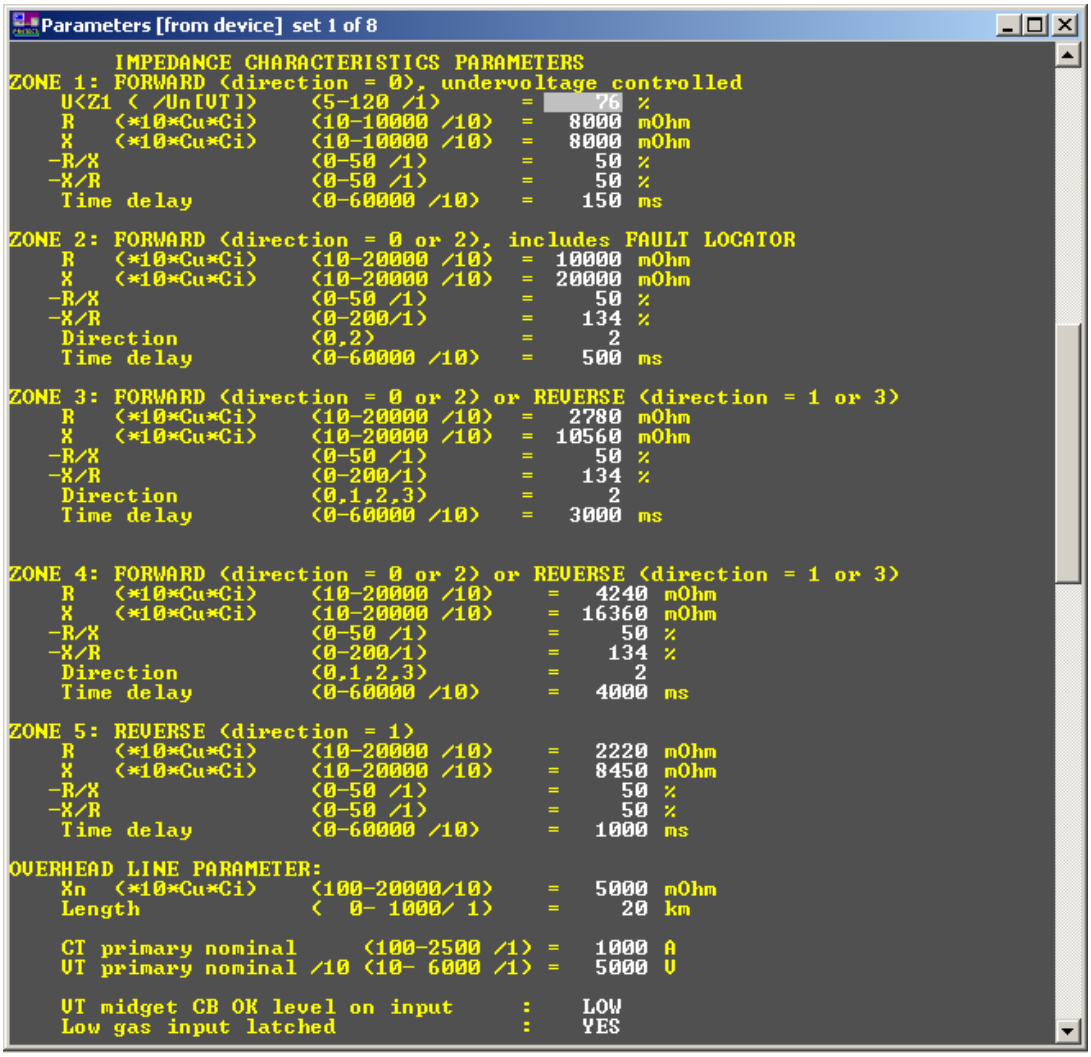
Warning: After program updating all 8 parameter packages must be set to avoid error signal of the self-check function.

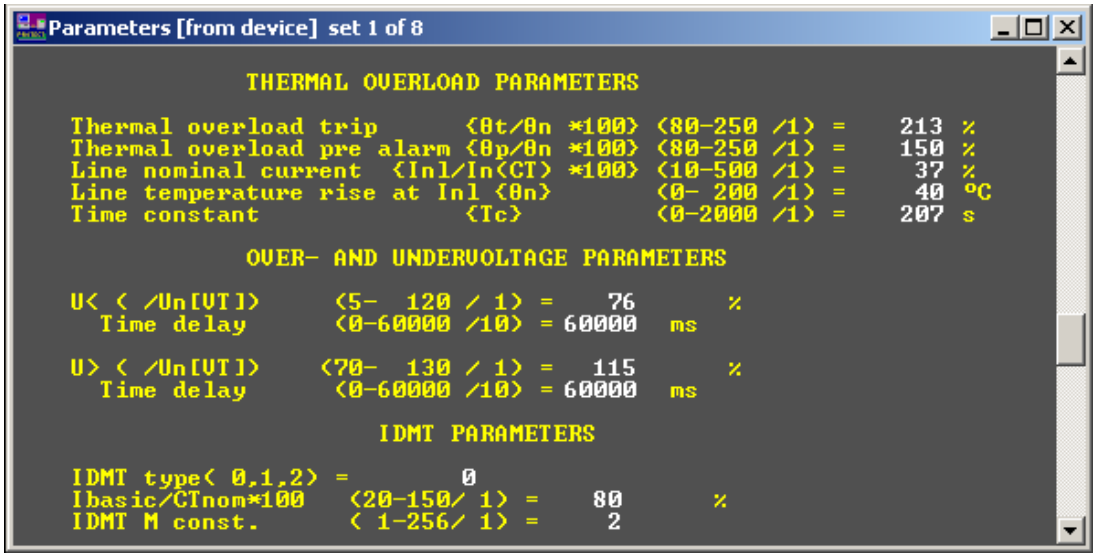
2.9 The screens of the "Protect for Windows" operating program

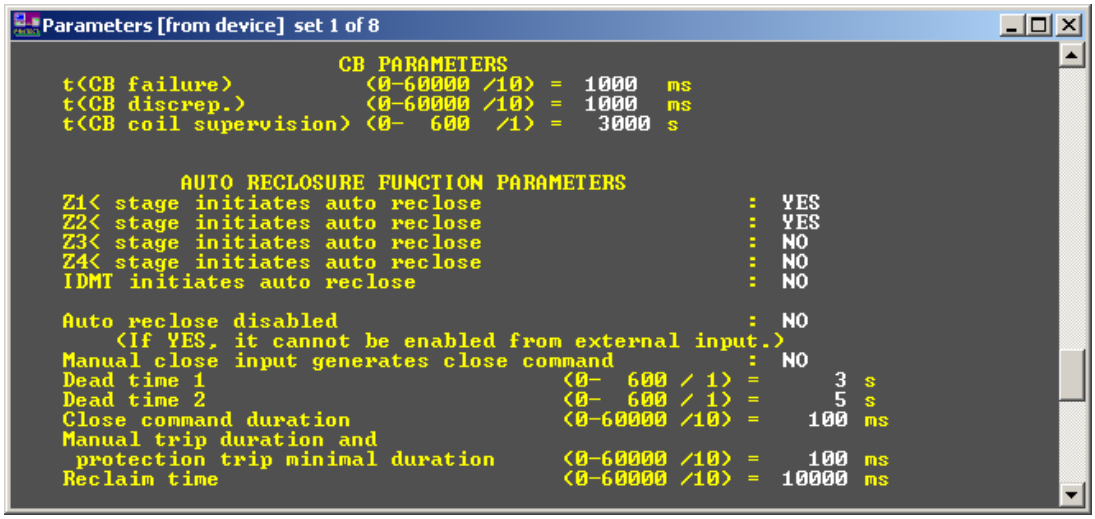
If a PC is connected to one of the serial ports of the device, or the device is integrated to the „Protection engineering workstation" then the program provides the following screens for supervising the device:

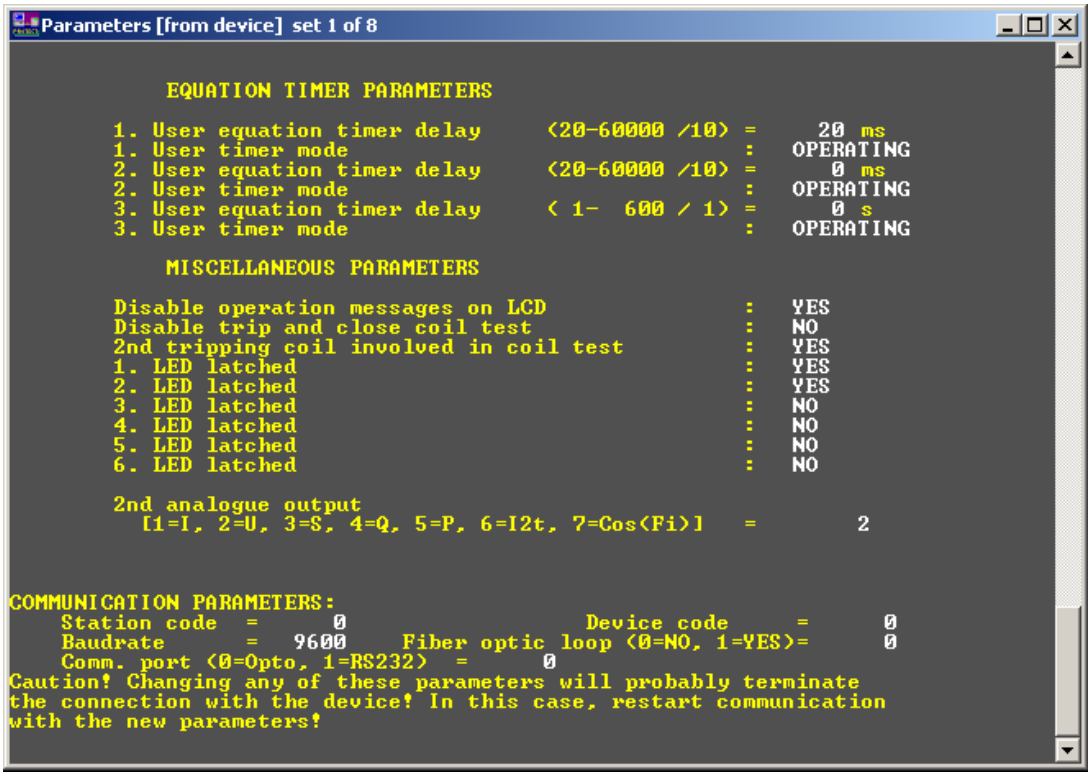
2.9.1 The Parameters window



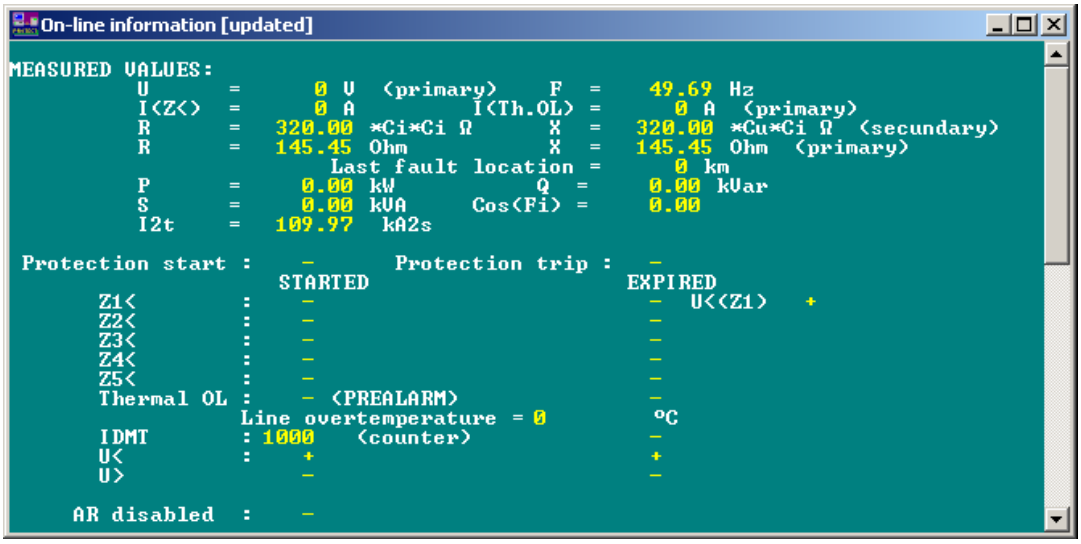

Parameters [from device] set 1 of 8
IMPEDANCE CHARACTERISTICS PARAMETERS
ZONE 1: FORWARD (direction = 0), undervoltage controlled
U<Z1 (/Un[VT]) (5-120 /1) = 76 %
R (*10*Cu*Ci) (10-10000 /10) = 8000 mOhm
X (*10*Cu*Ci) (10-10000 /10) = 8000 mOhm
-R/X (0-50 /1) = 50 %
-X/R (0-50 /1) = 50 %
Time delay (0-60000 /10) = 150 ms
ZONE 2: FORWARD (direction = 0 or 2), includes FAULT LOCATOR
R (*10*Cu*Ci) (10-20000 /10) = 10000 mOhm
X (*10*Cu*Ci) (10-20000 /10) = 20000 mOhm
-R/X (0-50 /1) = 50 %
-X/R (0-200/1) = 134 %
Direction (0,2) = 2
Time delay (0-60000 /10) = 500 ms
ZONE 3: FORWARD (direction = 0 or 2) or REVERSE (direction = 1 or 3)
R (*10*Cu*Ci) (10-20000 /10) = 2780 mOhm
X (*10*Cu*Ci) (10-20000 /10) = 10560 mOhm
-R/X (0-50 /1) = 50 %
-X/R (0-200/1) = 134 %
Direction (0,1,2,3) = 2
Time delay (0-60000 /10) = 3000 ms
ZONE 4: FORWARD (direction = 0 or 2) or REVERSE (direction = 1 or 3)
R (*10*Cu*Ci) (10-20000 /10) = 4240 mOhm
X (*10*Cu*Ci) (10-20000 /10) = 16360 mOhm
-R/X (0-50 /1) = 50 %
-X/R (0-200/1) = 134 %
Direction (0,1,2,3) = 2
Time delay (0-60000 /10) = 4000 ms
ZONE 5: REVERSE (direction = 1)
R (*10*Cu*Ci) (10-20000 /10) = 2220 mOhm
X (*10*Cu*Ci) (10-20000 /10) = 8450 mOhm
-R/X (0-50 /1) = 50 %
-X/R (0-50 /1) = 50 %
Time delay (0-60000 /10) = 1000 ms
OVERHEAD LINE PARAMETER:
Xn (*10*Cu*Ci) (100-20000/10) = 5000 mOhm
Length (0- 1000/ 1) = 20 km
CT primary nominal (100-2500 /1) = 1000 A
VT primary nominal /10 (10- 6000 /1) = 5000 V
VT midget CB OK level on input : LOW
Low gas input latched : YES

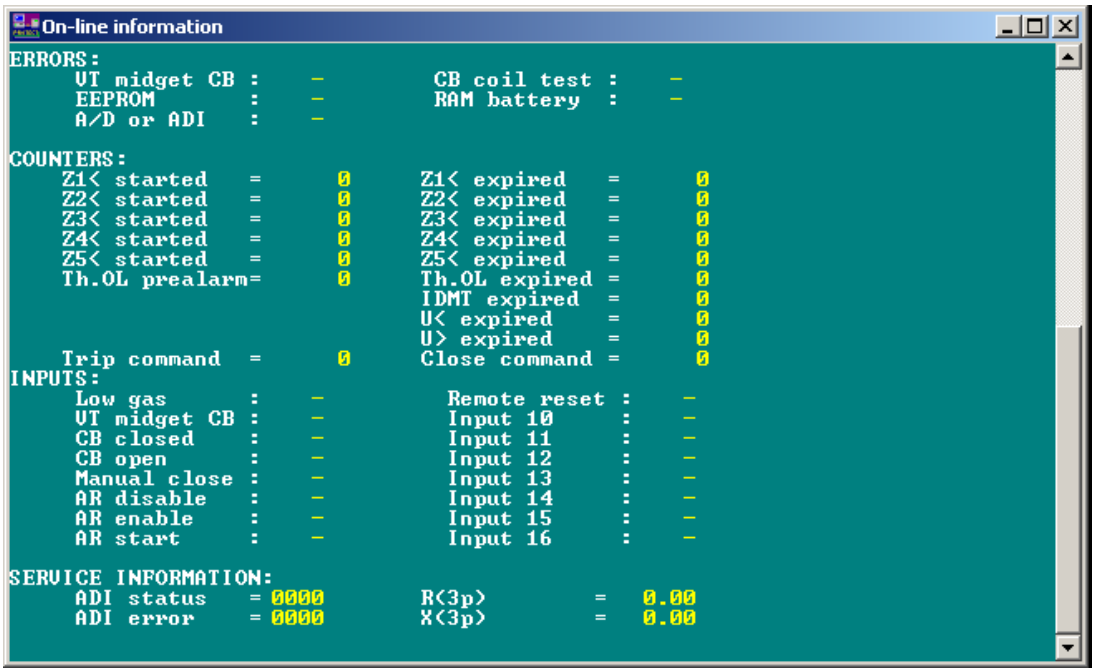

Parameters [from device] set 1 of 8
THERMAL OVERLOAD PARAMETERS
Thermal overload trip (θt/θn *100) (80-250 /1) = 213 %
Thermal overload pre alarm (θp/θn *100) (80-250 /1) = 150 %
Line nominal current (Inl/In(CT) *100) (10-500 /1) = 37 %
Line temperature rise at Inl (θn) (0- 200 /1) = 40 °C
Time constant (Tc) (0-2000 /1) = 207 s
OVER- AND UNDERVOLTAGE PARAMETERS
U< (/Un[VT]) (5- 120 / 1) = 76 %
Time delay (0-60000 /10) = 60000 ms
U> (/Un[VT]) (70- 130 / 1) = 115 %
Time delay (0-60000 /10) = 60000 ms
IDMT PARAMETERS
IDMT type(0,1,2) = 0
Ibasic/CTnom*100 (20-150/ 1) = 80 %
IDMT M const. (1-256/ 1) = 2


Parameters [from device] set 1 of 8
CB PARAMETERS
t(CB failure) (0-60000 /10) = 1000 ms
t(CB discrep.) (0-60000 /10) = 1000 ms
t(CB coil supervision) (0- 600 /1) = 3000 s
AUTO RECLOSURE FUNCTION PARAMETERS
Z1< stage initiates auto reclose : YES
Z2< stage initiates auto reclose : YES
Z3< stage initiates auto reclose : NO
Z4< stage initiates auto reclose : NO
IDMT initiates auto reclose : NO
Auto reclose disabled : NO
(If YES, it cannot be enabled from external input.)
Manual close input generates close command : NO
Dead time 1 (0- 600 / 1) = 3 s
Dead time 2 (0- 600 / 1) = 5 s
Close command duration (0-60000 /10) = 100 ms
Manual trip duration and
protection trip minimal duration (0-60000 /10) = 100 ms
Reclaim time (0-60000 /10) = 10000 ms

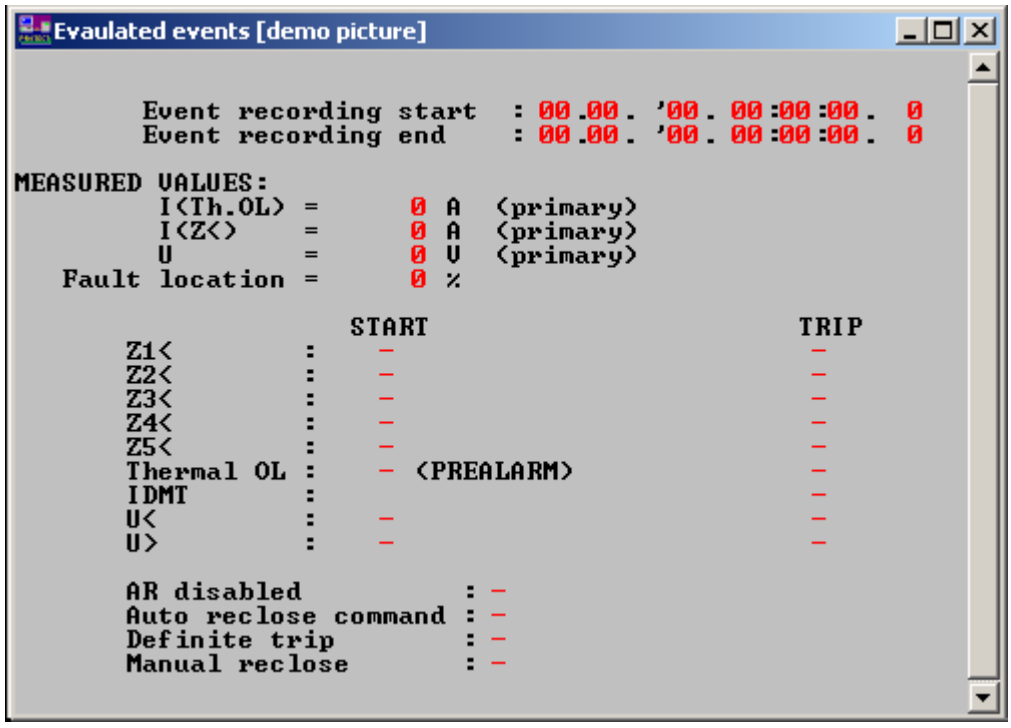

Parameters [from device] set 1 of 8
EQUATION TIMER PARAMETERS
1. User equation timer delay (20-60000 /10) = 20 ms
1. User timer mode : OPERATING
2. User equation timer delay (20-60000 /10) = 0 ms
2. User timer mode : OPERATING
3. User equation timer delay (1- 600 / 1) = 0 s
3. User timer mode : OPERATING
MISCELLANEOUS PARAMETERS
Disable operation messages on LCD : YES
Disable trip and close coil test : NO
2nd tripping coil involved in coil test : YES
1. LED latched : YES
2. LED latched : YES
3. LED latched : NO
4. LED latched : NO
5. LED latched : NO
6. LED latched : NO
2nd analogue output
[1=I, 2=U, 3=S, 4=Q, 5=P, 6=I2t, 7=Cos(Fi)] = 2
COMMUNICATION PARAMETERS:
Station code = 0 Device code = 0
Baudrate = 9600 Fiber optic loop (0=NO, 1=YES)= 0
Comm. port (0=Opto, 1=RS232) = 0
Caution! Changing any of these parameters will probably terminate
the connection with the device! In this case, restart communication
with the new parameters!

2.9.2 The On-line window

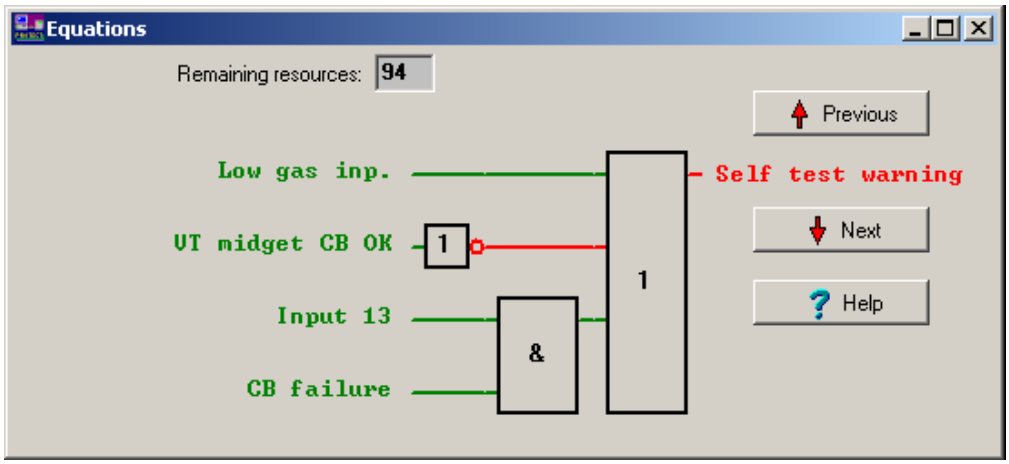

On-line information [updated]
MEASURED VALUES:
U = 0 V (primary) F = 49.69 Hz
I<Z< = 0 A I<Th.OL> = 0 A (primary)
R = 320.00 *Ci*Ci Ω X = 320.00 *Cu*Ci Ω (secundary)
R = 145.45 Ohm X = 145.45 Ohm (primary)
Last fault location = 0 km
P = 0.00 kW Q = 0.00 kVar
S = 0.00 kVA Cos(Fi) = 0.00
I2t = 109.97 kA2s
Protection start : – Protection trip : –
STARTED EXPIRED
Z1< : – – U<(Z1) +
Z2< : – –
Z3< : – –
Z4< : – –
Z5< : – –
Thermal OL : – (PREALARM) –
Line overtemperature = 0 °C
IDMT : 1000 (counter) –
U< : + +
U> : – –
AR disabled : –


On-line information
ERRORS:
VT midget CB : – CB coil test : –
EEPROM : – RAM battery : –
A/D or ADI : –
COUNTERS:
Z1< started = 0 Z1< expired = 0
Z2< started = 0 Z2< expired = 0
Z3< started = 0 Z3< expired = 0
Z4< started = 0 Z4< expired = 0
Z5< started = 0 Z5< expired = 0
Th.OL prealarm= 0 Th.OL expired = 0
IDMT expired = 0
U< expired = 0
U> expired = 0
Trip command = 0 Close command = 0
INPUTS:
Low gas : – Remote reset : –
VT midget CB : – Input 10 : –
CB closed : – Input 11 : –
CB open : – Input 12 : –
Manual close : – Input 13 : –
AR disable : – Input 14 : –
AR enable : – Input 15 : –
AR start : – Input 16 : –
SERVICE INFORMATION:
ADI status = 0000 R(3p) = 0.00
ADI error = 0000 X(3p) = 0.00

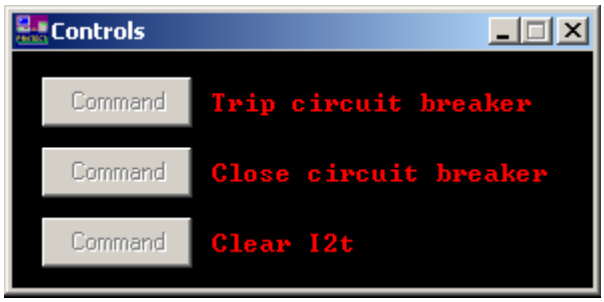
2.9.3 The Evaluated events window


Evaulated events [demo picture]
Event recording start : 00.00. '00. 00:00:00. 0
Event recording end : 00.00. '00. 00:00:00. 0
MEASURED VALUES:
I(Th.OL) = 0 A (primary)
I(Z<) = 0 A (primary)
U = 0 V (primary)
Fault location = 0 %
START
TRIP
Z1< : – –
Z2< : – –
Z3< : – –
Z4< : – –
Z5< : – –
Thermal OL : – (PREALARM) –
IDMT : –
U< : – –
U> : – –
AR disabled : –
Auto reclose command : –
Definite trip : –
Manual reclose : –

2.9.4 The Equations window (Example)



2.9.5 The Controls window



3 Design of DRFP-EP devices

The information related with the design of the devices is described „*EPCP-2004*" documentation.

The arrangement of the modules, the connections is specific to the ordered device. All these information is supplied as an attachment of the delivered device.

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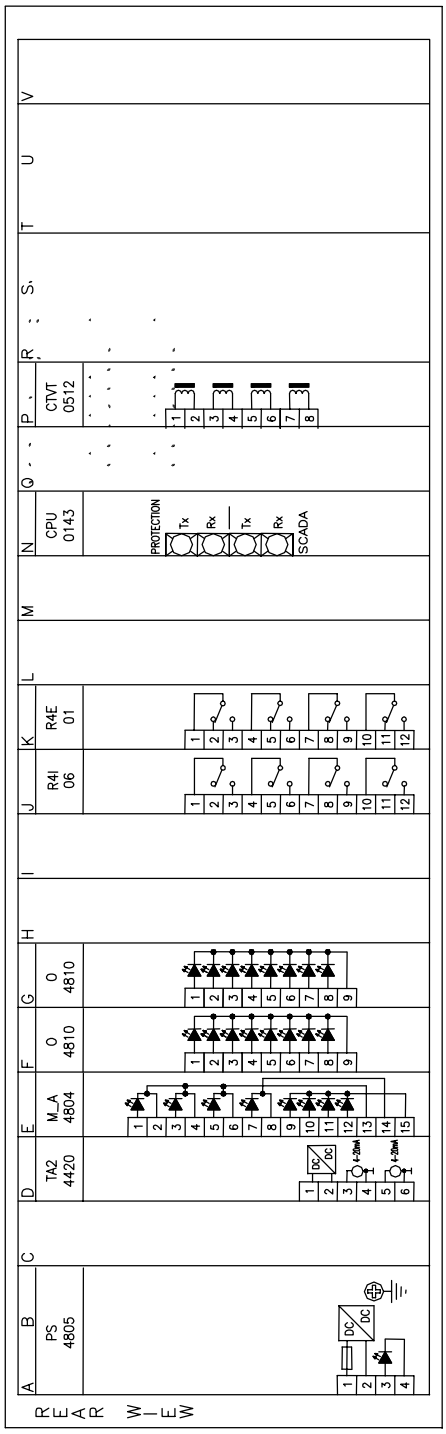
4 Drawings



PROTECTA Electronics Co.Ltd.

Fig.Nr.: FR–06–13418–01

DRFP–EP

Arrangement of PCB's

P CTVT/0512 [5A,100V]		
No.	Name	Term.
1	VT	
2	VT	
3		
4		
5	CT(Z<,IDMT)	
6	CT(Z<,IDMT)	
7	CT(ThOL)	
8	CT(ThOL)	

K R4E/01		
No.	Name	Term.
1	K1 +	
2	K1	
3	K1	
4	K2 +	
5	K2	
6	K2	
7	K3 +	
8	K3	
9	K3	
10	SELF TEST+	
11	SELF TEST	
12	K4	

J R4I/06		
No.	Name	Term.
1	+	
2		
3	To I.Trip.Output	
4	+	
5		
6	To.II.Trip.Output(if exist)	
7	+	
8		
9	To Close Output	
10	K8+	
11		
12	K8	

G O/4810 [48V]		
No.	Name	Term.
1	LOW GAS	
2	VT midget CB	
3	CB CLOSED	
4	CB OPEN	
5	MANUAL CLOSE	
6	AR DISABLE	
7	AR ENABLE	
8	AR START	
9	OPTO- (1-8)	

F O/4810 [48V]		
No.	Name	Term.
1	REMOTE RESET	
2	INP.10	
3	INP.11	
4	INP.12	
5	INP.13	
6	INP.14	
7	INP.15	
8	INP.16	
9	OPTO- (1-8)	

E M_A/4804 [48V]		
No.	Name	Term.
1	+	
2	To I.Trip.Output	
3	+	
4	To.II.Trip.Output(if exist)	
5	+	
6	To Close Output	
7	In0404+	
8	In0404	
9	In0405	
10	In0406	
11	In0407	
12	In0408	
13	OPTO- (1-6)	
14	OPTO- (7,8)	
15	OPTO- (9-12)	

D TA2/4420		
No.	Name	Term.
1	Supply+	
2	Supply-	
3	AN.AUT.1	
4	AN.AUT.1	
5	AN.AUT.2	
6	AN.AUT.2	

A B PS4/4805 [48]		
No.	Name	Term.
1	Supply+	
2	Supply-	
3	Clock syncron+	
4	Clock syncron-	

PROTECTA Electronics Co. Ltd

DRFP-EP
External Connections

Fig.No.:
FR-06-13148-01